Implementing Wireless Capsule Endoscopy WCE In Digestive System Diagnostics

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Abstract

*The purpose of this research is to discuss the **revolutionary endoscopy** method **WCE** that would enhance the diagnostic accuracy and reliability level. Additionally, a comparison has been made with other currently in practice endoscopy methods to single out the strengths and advantages of such endoscopy method.*
*The **limitation of this research** caused by limited up to date data due to the restrict privacy policy normally adopted by hospitals regarding releasing patients information. This limitation will impose a partially outdated comparison results and conclusions. However, the past trends showed a steady increase in the number of medical facilities that decided to approve the usage of the WCE. These trends are derived from direct interactions with various medical communities.*
This paper originality and value comes from the fact that increasing number of patients showed a serious reluctant toward continuing all their prescribed medical testing or procedures. Consequently, serious implication can be expected affecting those patients' health. WCE if understood correctly by both patients and doctors will have a positive impact on the success of diagnostic and treatment statistics.

Introduction

The human digestive system has many organs; such as: the ***esophagus***, ***stomach***, ***small intestine***, and ***large intestine***, etc. Therefore, many different types of diseases have been discovered and diagnosed through the years.

Endoscopes have been the most important diagnostic tool used to examine the upper and the lower parts of the digestive system. Nevertheless, these ***traditional endoscopes*** suffer from ***severe limitation*** due to their inability to visualize the entire digestive system.

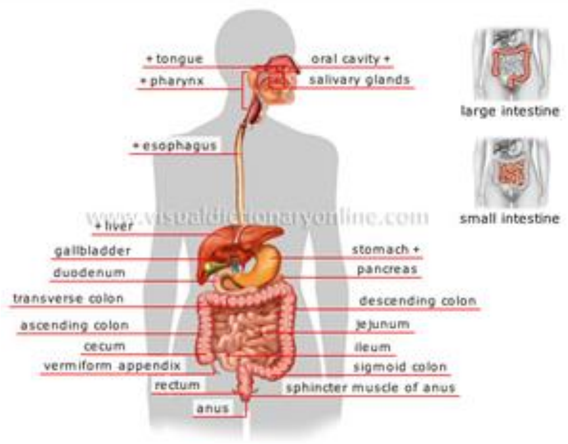

Fig 1: Human Digestive System

Other ***surgical approaches*** are in use today and can provide a high level of diagnostic data. However, high costs and after surgery complications are serous disadvantages.

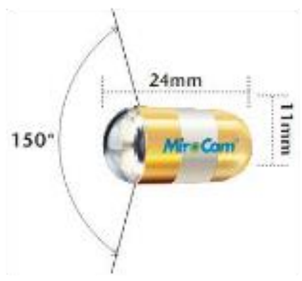

Fig 2: WCE Wireless Capsule Endoscopy Dimensions

WCE as a promising alternative was approved by FDA in 2001 in United States. Many patients have benefited from this revolutionary technology worldwide.
However, because it is a recent advancement, there is a scarcity of professionals experienced to use this technology.

WCE Design Basics:

- Dimensions: 11 X 24 mm (fig 2). Thus, it is easy to be swallowed
- The front end of the WCE has micro camera "Optical Dome"
- Light unit built from powerful LEDs (Light Emitting Diodes)
- Wireless transmitter that has short range because of the size of the WCE
- Battery enough to operate the device for about eight to ten hours.

WCE Disadvantages:

WCE camera can be configured by several parameters. However, the most interesting factor is number of ***captured images*** or ***frames per second (FPS)*** which will count to the total time needed to view these images. Usually, this time is about 6 – 8 hours of continuous video stream. As a result, some medical professionals find it unpractical to analyze the information derived from WCE devices. When WCE finishes its work, doctors will be able to download all captured images (typically from ***50,000 to 100,000***) and analyze them.

- Substantial research activities on how to summarize or compress captured images.
- Benefitting from artificial intelligence in designing an automated computer systems
- There are already available many algorithms for objects detection and tracking

The Paper Model

Fig 3: the Model of Implementing WCE in Digestive System Diagnostic.

Dependent Variable 1: WCE is a Painless Procedure

*"The development of wireless capsule endoscopy allows **painless imaging** of the small intestine (Mylonaki, Fritscher-Ravens, & Swain, 2003)* p2." In many times this is the reason why patients refuse to accept such procedures, putting their health at risks. "*Colonoscopy is sometimes painful for the patient and often difficult for the endoscopists, but it is hard to predict how difficult or painful the examination will be* (Hull & Church, 1994) p12."

In a recent study for, a questionnaire was distributed to 180 patients, the results were:

- 14% out of the total participating patients have expressed their experience with endoscopy as a ***painful process***
- 59% find it as an ***oppressive***
- 47% reported a ***throat ache***
- Other group of patients has expressed an increased level of ***anxiety***, ***depression*** before administering endoscopy

Dependent Variable 2: WCE is an Advancement in Endoscopy

- WCE innovation opened the door wide to many advanced algorithms techniques. "*The wireless capsule endoscopy (WCE) invented by Given Imaging has been gradually used in hospitals due to its great breakthrough that it can view the entire small bowel for gastrointestinal diseases (Li & Meng, 2009a) p21.*"
- ***Video Summarization*** algorithm is applied to filter out all faulty, out of scope to increase the reliance level

Dependent Variable 3: WCE has a 3D Capability

- Due to many difficulties facing WCE, such as ***limited Illumination*** and ***irregular motion*** of the capsule endoscope 3D become a potential solution.
- A recent paper for has demonstrated the possibility for utilizing ***image segmentation*** to obtain a 3D reconstruction of the mucosal tissues
- However, this reconstruction requires ***sophisticated mathematical models*** that normally consumes large amount of computing processing power

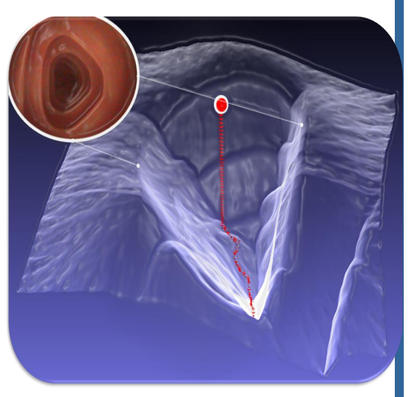

Fig 3: WCE 3D Trajectory Sample

Dependent Variable 4: WCE Images are Numerical Representation

- Computer aided images are just ***numerical representations***
- This fact makes it possible to ***automatically analyze*** images and detect interesting textures, that is, any abnormal structure that can be defined as a medial concern Doctors usually spend long time doing such analysis manually and generally report that this process became ***tedious and unreliable*** after a short while. Stefanini and others pointed that computer aided detection system is feasible, though it has limitations as well
- Consequently, it is very important to design algorithms that can automatically recognize abnormal structures. These are known as objects detection algorithms

Dependent Variable 5: Most of WCE Images are Wasteful

- A study for (Nawarathna, Oh, Yuan, Lee, & Tang, 2010) has found that only ***less than 5%*** of the total captured images typically have ***useful information*** regarding abnormalities
- Some reasons are:
  - While WCE moving inside patient's digestive system; it faces ***guts movements*** that makes it turn and flip. As a result, many captured images become wasteful
  - ***Limited illumination*** yet is another problem. Although a powerful illumination source is built in WCE, it still not enough to illuminate all antra

Importance of the Model

- This work is important because it provides an explanation of relatively new technology that many people still not aware of. This one of the reason why ***WCE still did not receive attention that it deserves*** from both research and medical practice communities
- Doctors generally tend to use what they already know and skilled in using. Therefore, they are ***reluctant in delving inside new technologies*** that they do not yet have a complete control on its effects or interactions with other environmental factors
- From this point of view, we believe in the importance of spreading positive understanding among all interested communities including the general public.

Conclusion

- ***WCE is to dominant the field of endoscopy*** in near future. Eilersten has claimed that while many other endoscopy technologies are still in practice widely, continuous evaluation reports and surveys are published constantly to address their side effects on patients' health
- On the other hand, WCE as is still relatively recent technology, it is therefore the ***most expensive*** compared to other endoscopy technologies. Such burden has a significant impact on adopting WCE especially in ***countries with low economy*** level. However, as new advancements and developments are published in this interesting and exciting field on daily basis, we strongly believe that the costs of implementing WCE should decrease dramatically in the coming few years. Nevertheless, other resources such as charity organizations and helping centers can be investigated to support the application of such new technology to needed individuals around the world

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Full list of references will be provided upon request.